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RETROSPECTIVE LATERAL SEFALOMETRIC ANALYSIS OF PATIENTS USING MANDIBLE ADVANCEMENT DEVICES IN THE TREATMENT OF OBSTRUCTIVE SLEEP APNEA SYNDROME

OBSTRÜKTİF UYKU APNE TEDAVİSİNDE MANDİBULAYI ÖNDE KONUMLANDIRAN APAREY YAPILAN HASTALARDA RETROSPEKTİF LATERAL SEFALOMETRİK İNCELEME

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ABSTRACT

Objective: Obstructive sleep apnea syndrome (OSAS) is a sleep disorder with occurs in the upper airway during sleep and is characterized by recurrent collapses. The mandible advancement device (MAD) is a successful treatment option for patients with moderate and severe OSAS. This study examines the effectiveness of the MAD appliance in patients diagnosed with OSAS.

Material and methods: The angle between A point, Nasion and Sella (ANB), angle between B point, Nasion and Sella (SNB) and lower respiratory tract changes in 20 cases diagnosed with OSAS and treated with MAD appliances were examined. The lateral cephalometric films of the patients before and after the appliance were evaluated by matching. The obtained data were statistically evaluated with the paired comparison t-test.

Results: In the measurements made with lateral cephalometric imaging of patients with and without appliances, the SNB and posterior airway size (PAS) values increased while the ANB values decreased. No change was observed in the SNA values.

Conclusion: According to lateral cephalometric imaging analysis, it can be said that MAD appliances are effective in the treatment of OSAS.

Keywords: Obstructive sleep apnea, mandible advancement device (mad), lateral cephalometry

ÖZ

Amaç: Obstrüktif uyku apne sendromu (OSAS) uyku sırasında üst hava yolunda meydana gelen ve tekrarlayan kollapslarla karakterize uyku düzensizliği sendromudur. Mandibulayı önde konumlandıran (MAD) apareyler orta ve ileri derecedeki OSAS hastalarında, başarı oranı yüksek bir tedavi seçeneğidir. Bu çalışmada OSAS tanısı alan hastalarda MAD apareyin etkisi incelenmiştir.

Gereç ve Yöntemler: OSAS tanısı konmuş ve MAD apareylerle tedavi edilen 20 vakanın, Nasion ve Sella arasının oluşturduğu açı (ANB), Nasion ve Sella arasının oluşturduğu açı (SNB) ve alt solunum yolu değişimleri incelenmiştir. Hastaların başlangıç ve aparey yapıldıktan sonraki lateral sefalometrik filmleri çakıştırılarak değerlendirildi. Elde edilen veriler t-testi ile istatistiksel olarak değerlendirildi.

Bulgular: Apareyli ve apareysiz hastaların lateral sefalometrik görüntüleme ile yapılan ölçümlerinde SNB ve PAS değerlerinde artarken ANB değerleri azalmıştır. SNA değerlerinde ise değişiklik olmadığı görülmüştür.

Sonuç: Lateral sefalometrik görüntüleme ölçümlerine göre MAD apareylerinin OSAS tedavisinde etkili olduğu söylenebilir.

Anahtar Kelimeler: Obstrüktif uyku apne, mandibulayı önde konumlandıran (MAD) apareyler, lateral sefalometri

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INTRODUCTION

There are upper airway sleep disorders that can be exacerbated from simple snoring to obstructive sleep apnea syndrome (OSAS) (1). OSAS is the involuntary interruption of breathing for 10 seconds or more during the breathing phase of the upper respiratory tract during sleep (1,2). OSAS with a prevalence ranging from 1-5% (2); causes systemic hypertension, ischemic heart disease, cardiac arrhythmias, restless and insufficient sleep, bronchial hyperreactivity, overlap syndrome, cerebrovascular diseases, cognitive impairment, headache, excessive daytime sleepiness, anxiety, gastro-oesophageal reflux secondary polycythemia, depression and work accidents and thus leads to a decrease in quality of life (1-4). The etiology of OSAS is multifactorial. It has been reported that it is twice as common in middle-aged men as in women. Obesity, alcohol and smoking habits, use of antidepressant drugs, otorhinolaryngological diseases, macroglossia, micrognathia and retrognathia also play a role in the emergence of the syndrome (1,2,4-7).

One of the most prominent symptoms of OSAS is snoring (4). It is seen that snoring is 25% more common in men than in women in the adult population. Snoring is caused by the vibration of the soft tissues in the airways. This condition is usually caused by airflow creating excessive pressure by narrowing the upper airway ducts. Although snoring is always seen in OSAS patients, OSAS cannot be diagnosed in every patient with a snoring problem (7).

The most important diagnostic method of OSAS is polysomnography (PSG) recorded overnight in the sleep laboratory. PSG is the "gold standard" in the diagnosis of OSAS (1,2). According to the American Academy of Dental Sleep Medicine (AADSM), when taking dental and medical anamnesis, it is necessary to examine the reports sent by the consulted physician; to control the teeth and restorations; examine the soft tissue; examine the intraoral and parafunctional habits; examine the TMJ; examine the periodontal condition; control the occlusion; request a cephalometric film; and to obtain the necessary models for diagnosis and appliance construction (8). Lateral cephalometric films should be used in determining the problems related to the maxilla-mandible relationship and in planning the treatment with the appliance to be applied to the mandible in cases (9,10). The skeletal and airway anatomy of the OSAS and/or snoring patient can be easily observed through lateral cephalometric imaging. The points used for measurements on lateral cephalometric imaging on the midline are the deepest point of the concavity, located between the Spina nasalis anterior and the Prosthion (A point), and the most concave points of the anterior contour of the Mandibular symphysis (B point). The SNA angle formed between the A point, Nasion and Sella and the SNB angle formed between B point, Nasion and Sella are the angles that provide information about the development of the lower jaw and its position relative to the upper jaw (10,11). The ANB angle, which shows the positions of the maxilla and mandible relative to each other, and the measurement of the distance between the dorsal surface of the tongue and the posterior pharyngeal wall on the line connecting the B and gonion points, or in other words, the length of the lower airway space PAS are also factors that should be evaluated in lateral cephalometry (10). Moreover, the models of the maxilla and mandible and their relationship recordings can be used to determine how retrognatic the mandibular position is and how effective it is in sliding the tongue towards the posterior and lateral pharyngeal wall (11).

The American Sleep Diseases Association reported that the use of oral devices in patients with moderate to severe OSAS should be used by patients who refuse nasal CPAP (Continuous positive airway pressure) treatment, and in patients with primary snoring or a diagnosis of mild OSAS. Oral devices can be used in cases that are not suitable for preventive treatments such as sleep position change and weight loss and cannot be treated with these methods (8,9). Oral appliances have many advantages such as being inexpensive; time-effective; easy to carry; being more easily tolerated by patients; being a non-invasive and reversible method; not affecting the daily life of the patient; and having suitable appliance options for patients with or without teeth (8). In addition, the use of oral appliances can cause side effects such as dry mouth, TMJ dysfunction, tooth movements and occlusion disorders. There are also some disadvantages such as requiring lifelong use and not being able to control the patient's compliance with the treatment (9).

The most preferred and most successful oral appliances are mandibular advancement devices (MAD). Although there are many different designs of MADs, the one-piece model is generally preferred. They attach to the jaws by means of metal clasps or acrylic parts of the plaque to the outer surfaces of their teeth (9). There are gaps in the middle of the appliance for air passage and these are made to position the mandible forward. In this way, they both expand the airway and affect the genioglossus muscle. It is simple and inexpensive to prepare and it is easy for patients to tolerate these appliances (2,8,9,11). The aim of this study is to retrospectively examine the changes in the lower respiratory tract and the jaw relationships of the patients during this treatment in our clinics. In this study, the changes in the lower air space changes of the patients before and after the treatment and the amount of change of the mandible with respect to the maxilla, as well as the changes of the mandible according to the cranial base were evaluated.

MATERIAL and METHODS

Laterocephalometric films of patients who were recently diagnosed with mild or moderate OSAS (apnea-hypopnea index between 20 and 37) in Biruni University Faculty of Dentistry- Kırıkkale University Faculty of Dentistry, during the treatment with the oral appliance, were retrospectively analyzed for diagnosis and post-treatment evaluation. (Biruni University Non-Invasive Clinical Research Ethics Committee Decision No: 2021 /51-26) The PAS (posterior airway size), SNA, SNB, ANB, points and angles were measured and compared on the lateral cephalometric images taken before and after the appliance, whose age and gender were recorded. (Figure 1). The sample size required for the study

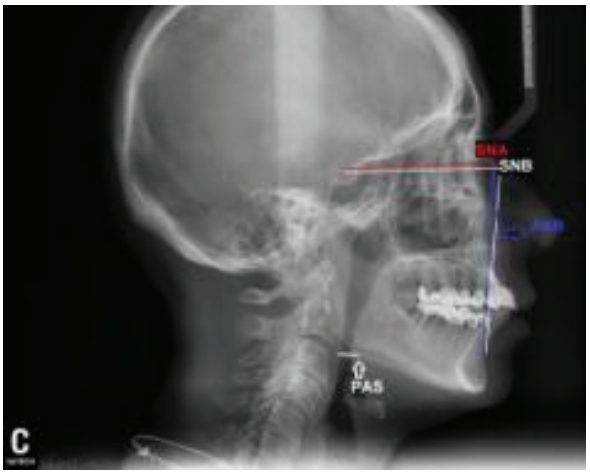

Figure 1: Lateral cephalometric measurement points in Case 3 (Pre-treatment)

was calculated with a power analysis software (G*Power 3.0.10, Kiel, Germany) at a significance level of 0.05 and a power of 80%, and it was determined that a minimum of 20 individuals were required. The study details were explained to all participants and a signed consent form was obtained. The study included data from patients previously diagnosed with mild or moderate OSAS who were treated with the oral appliance and had lateral cephalometric recordings. Data belonging to patients who did not have lateral cephalometric records or who were diagnosed with advanced OSAS were excluded. In addition, the following criteria were sought in patients: not having any pathology in the airway, not having any congenital and/or acquired anomalies (cleft lip and palate etc.), not having received orthodontic treatment before, detecting reference points properly on initial radiographs and having sufficient image quality, and correct head position on lateral cephalometric film to be positioned. The records of patients who did not meet the criteria were not evaluated. All patients admitted to the study had used intraoral appliances prepared by controlling the patient's lower jaw movements following the temporomandibular joint examination. After all necessary treatments were performed in the mouth of the patients, upper and lower jaw impressions were obtained using additional silicone material (Elite HD+, Zhermack, Rovigo, Italy) for the construction of oral appliances. Models were created using type IV plaster (Jade Stone; Whip Mix Corp). Acrylic splints (Heraeus Kulzer, Berkshire, UK) were prepared for the upper and lower jaws separately. Then, the splints were customized for the upper and lower jaws. While the splints were in the patient's mouth, the lower jaw was fixed in a forward position using zinc oxide eugenol (TempBond; Kerr Corp) and transferred to a semi-adjustable articulator (Articulator #3140; Whip Mix Corp). In that position, the gap between the two splints was filled with acrylic in a key-lock relationship. Polymerization was performed by leaving gaps in the front region to allow the patient to breathe, and the appliance was completed. These appliances have a height of 75% of the maximum amount of protrusion and are positioned anteriorly to the mandible and are called "mandibular advancement devices" (Figure 2-3).

Figure 2: Mandibular and maxillary models and MAD appliance for Case 1

Figure 3: Case1 Intraoral view of the MAD appliance

The 20 patients included in the study were grouped as Class 1, Class 2, and Class 3 according to the ANB angle (norm value 2°±2°). (Class 1 group: 4°>ANB>0°, Class 2 group: ANB>4°, Class 3 group ANB<0°). The N (Nasion) point used as a reference in our evaluation is the most anterior point of the Sutura Frontonasalis and the deepest point of the recess in that region. Point A is the deepest point of the maxillary anterior alveolar bony recess below the Anterior Nasal Spina (ANS), while point B is the deepest point of the mandibular anterior alveolar bony recess above the Pogonion point. Lateral cephalometric images of all included patients were taken using the Carestream CS 9000 (Kodak Dental Systems, NewYork, USA) device with the standard technique (60-90 kVp, 2-15 mA, 1.2 sec.). Recorded lateral cephalometric films were run on an Adobe Photoshop program and measurements were made from the same points (Figure 4-5). Measurements were made by a single, experienced researcher. (A.B) According to the measurements obtained, the statistical evaluation of the differences between the measurement values before the oral appliance application and with the oral appliance was performed with the t-test (paired comparison t-test). (SPSS v23; IBM)

Figure 4: Case 3-Lateral cephalometric imaging with MAD appliance

Figure 5: Case 5- Lateral cephalometric films (Pre-treatment and post-treatment, respectively)

RESULTS

According to pre-treatment and post-treatment Lateral sefalometric imaging, 17 patients (11 females and 6 males) had Class 1 occlusion, and 3 patients (2 female and 1 male) had Class 2 occlusion (ANB first measurement) (Table 1).

An increase in SNB and PAS values, a decrease in ANB values, and no change in SNA values in the measurements made with

Table 1: Type of Occlusion

Man		Gender		Total
		Woman		
Occlusion	class 1	11	6	17
	class 2	1	2	3
Total		12	8	20

Table 2: Descriptive Analysis

	Minimum	Maximum	Mean	Std. Deviation
AGE	28.00	63.00	40.2500	8.18776
SNA initial	80.00	84.00	82.0500	1.27630
SNA final	80.00	84.00	82.0500	1.27630
SNB initial	77.00	81.00	78.9750	1.22984
SNB final	80.00	84.00	81.7000	1.12858
PAS initial	3.00	4.80	3.7000	.55346
PAS final	7.00	11.00	8.7150	1.04139
ANB initial	3.50	7.00	4.2750	1.00623
ANB final	.80	4.50	1.4950	1.11094

AGE: Hastaların yaşlarını göstermektedir, SNA: angle between A point, Nasion and Sella, SNB: angle between B point, Nasion and Sella, PAS: Posterior airway size, ANB: angle between A point, Nasion and Sella.

lateral cephalometric imaging of the patients with and without appliances were observed (Table 2). The increase between SNB initial value and SNB final value and the increase between the PAS initial value and post-treatment value were statistically significant. (p= .000) (Table 3). Moreover, Table 3 shows that the ANB value, that is, the angle of the mandible with the maxilla, decreased after the snoring appliance and this value was statistically significant. (p=.000). No change in SNA angles was observed.

DISCUSSION

Intraoral devices play an active role in the treatment of OSAS. In a study conducted in 2018, it was suggested that oral appliance treatment could be an alternative to CPAP in patients with mild and moderate OSAS. Moreover, it has been reported that

Table 3: Paired Test

Pair	Paired Differences				t	df	Sig. (2-tailed)
	Mean	SD	95% Confidence				
			Lower	Upper			
ANB initial -ANB final	2.78000	.37219	2.60581	2.95419	33.404	19	.000
SNB initial- SNB final	2.72500	.76906	3.08493	2.36507	15.846	19	.000
PAS initial- PAS final	5.01500	1.02458	5.49452	4.53548	21.890	19	.000

ANB: Angle between A point, Nasion and Sella, SNB: Angle between B point, Nasion and Sella, PAS: Posterior airway size, SD: Standard deviation.

oral appliances are more advantageous in terms of patient use and acceptability (9).

Dentists are part of the OSAS treatment process and should identify potential patients and refer them to the sleep laboratory for a polysomnography diagnosis and treatment planning. In a review of studies conducted with MAD in 2019; it was reported that snoring was treated at rates of up to 90% in 10 studies, and the apnea index decreased to a certain extent after treatment with intraoral devices in 18 studies (12).

In a case report presented by Güzel et al., it was suggested that patients' complaints were completely resolved after the use of the MAD appliance, and the apnea-hypopnea index decreased from 33 to 7 (13). In the protrusion study of Marklund et al., a 50% and 75% maximum protrusion amount was examined and it was shown that 75% maximum protrusion was more effective than 50% (14). For this reason, only patients using intraoral devices designed for 75% protrusion were included in our study.

Carvalho et al. prepared one of the two appliances of different designs in a way to keep the mandible at a 6-8 mm protrusion and approximately 8 mm (A) and the other (B) without protrusion of the mandible and with a vertical opening of 2 mm. As a result of the study, they found the A appliance to be more effective (15). In a meta-analysis conducted in 2018, the cephalometric method was not used in some of the studies examining the effects of appliances without protrusion and at 75% protrusion; in some, cephalometric examination of the airway was performed in addition to polysomnography. In some studies, the mandible is advanced up to 50% of its maximum protrusion, 70% in some, and 75% in others with an intraoral appliance. Based on the data compiled, the researchers reported that the recommended amount of protrusion is 50-75% of the maximum anterior positioning of the mandible (16). Moreover, there are studies stating that an increased amount of protrusion would lead to an increase in dental and skeletal side effects, and that less mandibular protrusion may cause a milder decrease in the number of apneas in general. However, gender and the amount of pharyngeal stenosis may also affect this mechanism (14). While the appliance used by patients in this study moves the lower jaw forward by 75% of the maximum protrusion, it also creates the amount of protrusion, which is defined as the maximum protrusion that the patient is comfortable with, giving the same values for almost every patient. Therefore, patients using appliances of different designs were not included in the evaluation.

In lateral cephalometric analysis; the PAS, SNA, PNS-P, Go-Pog, SNB, and MP-H points and angles are sufficient (10). This imaging method is also used in pharyngeal area measurements in OSAS patients, as well as in the diagnosis and treatment process. There are many studies showing the relationship between lateral cephalometric measurements and treatment results (8,11-13,15). In addition to studies reporting that enlargement occurs in the velopharynx with the use of MAD, there are also studies reporting that most enlargement occurs in the oropharynx and hypopharynx (8,11,15). Consistent with these data, an increase was observed in all three parts of the oropharynx, nasopharynx, and hypopharynx in the cases evaluated in our study.

Ng and Yow, in their study in 2019, reported that MAD oral appliances can be used effectively in the treatment of mild and moderate sleep apnea, and that these devices provide a significant reduction in the Apnea-hypopnea index and improvements in oxygen saturation (17). Furthermore, they reported an improvement in sleep quality, a reduction in daytime insomnia complaints, and 90% reported a reduction in snoring (17). Marklund et al. suggested that 80% of mild apnea cases, 65% of moderate apnea cases and 25% of severe apnea cases were successful in cases using MAD appliances (14). In a recent study, it was reported that it had successful results in 90% mild-moderate apnea treatment and 60% in moderate-severe apnea (18).

Although there are surgical treatments that provide 90% success, oral appliances are advantageous for patients who do not want to undergo surgery, are afraid, or do not have the cost of their operation covered. As such, their use is increasing given that the treatment success rate is close to surgical procedures (16-18). Furthermore, the complication rate after the use of intraoral appliances is very low. Intraoral appliances have a faster and higher treatment success than behavior modification therapy. MAD appliances can be used and accepted more easily by the patient than CPAP. Oral appliances have advantages such as occupying less space in volume, being easy to carry, being cost-effective and having low replacement costs. Although CPAP is the most effective treatment in the treatment of OSAS, it has been observed that 10% of the patients almost never try it and some patients discontinue the treatment. There are many studies indicating that MAD appliances are a highly successful treatment method in the treatment of OSAS and can be an alternative to CPAP (9,14,15,18). In addition, in a recent study, it was reported that MAD appliances positively affect the load distribution on the temporomandibular joint and periodontal ligament (19). In the treatment of OSAS, which requires a multidisciplinary approach, the dentist can take an active role in the treatment with the application of oral appliances (9,14,15,18).

This study revealed that MAD appliances after laterocephalometric measurements are effective in the treatment of OSAS. However, this study has some limitations as mentioned above. In our study, only patients with one type of appliance were evaluated, and the time of use of the appliances was not examined separately. Further investigations from diagnosis to treatment in further studies will provide more detailed information about the effectiveness of MAD devices.

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